

# NORMAL TEE EXAMINATION: APPLICATIONS, PITFALLS, PROBE INSERTION & MANIPULATION, RISKS & COMPLICATIONS



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ASCeXAM/ReASCE  
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19<sup>th</sup>  
A N N U A L

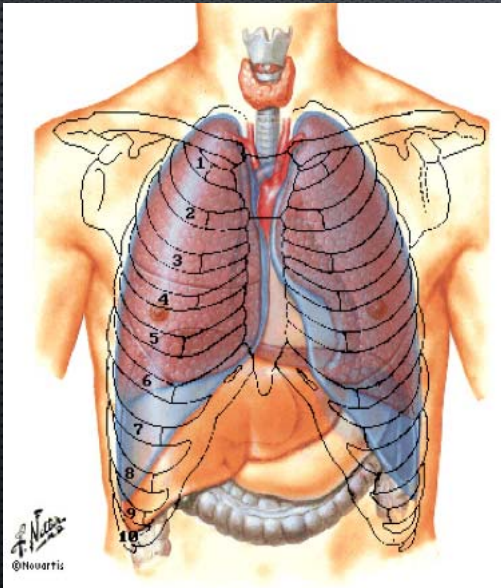
## DISCLOSURES

- NO FINANCIAL DISCLOSURES
- NO CONFLICTS OF INTEREST

## ROBUST POWER OF TRANSTHORACIC ECHO

- **LEFT HEART**
  - LV / LA SIZE
  - SYSTOLIC
  - DIASTOLIC
  - ISCHEMIC DISEASE
- **VALVES**
  - STENOSIS
  - REGURGITATION
  - PROSTHETIC
- **MASSSES**
  - ENDOCARDITIS
  - THROMBUS
  - TUMORS
- **RIGHT HEART**
  - SIZE AND FUNCTION
  - RV VALVES
  - PULMONARY HYPERTENSION
- **AORTA**
  - ROOT & PROXIMAL ASCENDING
  - AORTIC ARCH
- **CONGENITAL**
  - SEPTAL DEFECTS / PFO
  - AV CANAL & VARIANTS
  - TETRALOGY OF FALLOT
  - TGA
  - BAFFLES AND SHUNTS

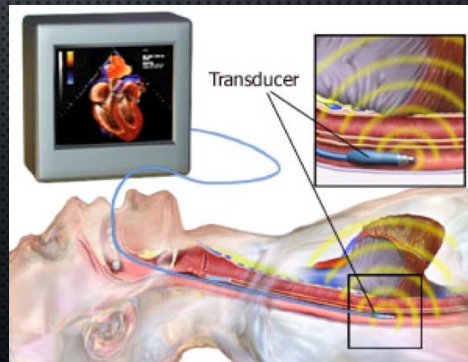
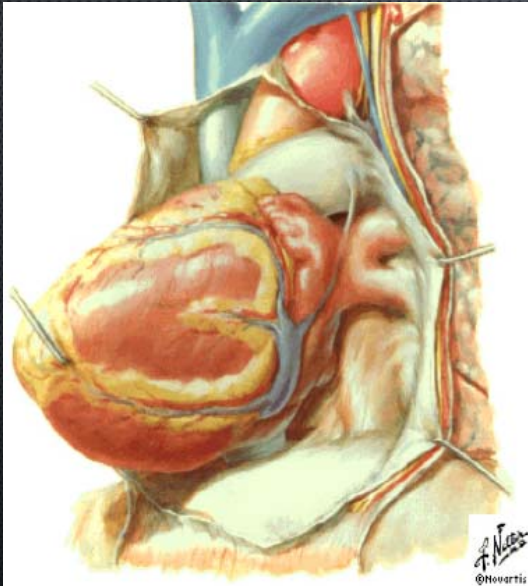
## FAILURE OF TRANSTHORACIC ECHO



- **POOR TRANSMISSION**
  - PULMONARY DISEASE
  - OBESITY / EXTREME UNDERWEIGHT
- **POOR RESOLUTION**
  - STRUCTURES <3 MM
- **POOR VISUALIZATION**
  - LEFT ATRIAL APPENDAGE
  - PV MORPHOLOGY
  - COMPLETE AORTIC EVALUATION
- **PROCEDURE GUIDANCE**
  - ASD CLOSURE, PVL CLOSURE
  - TRANSCATH VALVES, REPAIRS, LAA OCCLUDERS



## YOU KNEW YOU WANTED INVASIVE CARDIOLOGY!



## WE REVERE THE HOLY TEE MANUSCRIPT

### ASE GUIDELINES AND STANDARDS

#### Guidelines for Performing a Comprehensive Transesophageal Echocardiographic Examination: Recommendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists

Rebecca T. Hahn, MD, FASE, Chair, Theodore Abraham, MD, FASE, Mark S. Adams, RDCS, FASE,  
Charles J. Bruce, MD, FASE, Kathryn E. Glas, MD, MBA, FASE, Roberto M. Lang, MD, FASE,  
Scott T. Reeves, MD, MBA, FASE, Jack S. Shanewise, MD, FASE, Samuel C. Siu, MD, FASE,  
William Stewart, MD, FASE, and Michael H. Picard, MD, FASE, *New York, New York; Baltimore, Maryland;  
Boston, Massachusetts; Rochester, Minnesota; Atlanta, Georgia; Chicago, Illinois; Charleston, South Carolina; London,  
Ontario, Canada; Cleveland, Ohio*

J Am Soc Echocardiogr (2013) 26:21-64

## INDICATIONS FOR TEE

### GENERAL

- TTE NON-DX, FINDINGS CRITICAL
  - VENTILATED PATIENTS
  - BODY HABITUS LIMITATIONS
  - CHEST WALL INJURY / INCISION
- LEFT ATRIAL APPENDAGE
- THORACIC AORTA
- SMALL STRUCTURES (<3MM)
- FAR-FIELD TTE STRUCTURES
- PROSTHETIC VALVES
- ABSCESES

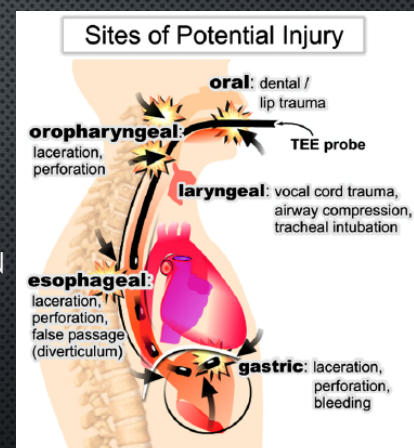
### SPECIALIZED

- CRITICALLY ILL
  - EMERGENCY DIAGNOSIS
  - HEMODYNAMIC MONITORING
- PROCEDURE GUIDANCE
  - SEPTAL CLOSURE
  - TRANSCATHETER VALVES / PLUGS
  - VALVULOPLASTY
  - LA APPENDAGE OCCLUDE
- INTRAOPERATIVE
  - CARDIAC (VALVES, RISKY CABG)
  - NONCARDIAC

Adapted from: Hahn RT, et al. JASE (2013) 26:921-64

## POTENTIAL COMPLICATIONS – PASSING PROBE

- **ORAL**
  - LIP TRAUMA, TOOTH DAMAGE/LOSS
- **PHARYNGEAL**
  - LACERATION, HEMATOMA, PERFORATION
  - LARYNGOSPASM
  - VOCAL CORD TRAUMA, TRACHEAL INTUBATION
- **ESOPHAGEAL**
  - PERFORATION, LACERATION, DIVERTICULUM
- **GASTRIC**
  - LACERATION, PERFORATION



Hilberath JN, et al. JASE (2010) 23:1115-1127



## POTENTIAL COMPLICATIONS – 2

- **ASPIRATION**
  - CHEMICAL, BACTERIAL (PNEUMONIA)
- **SEDATION-RELATED**
  - HYPOXEMIA, HYPERCAPNIA, AIRWAY OBSTRUCTION
- **THERMAL**
  - ESOPHAGEAL / GASTRIC BURN (INCL. BLEEDING, PERFORATION)
  - WATCH THE TEMPERATURE!! FREEZE EARLY
- **PRESSURE-RELATED**
  - OVER-FLEXION, ESPECIALLY WITH PROBE RETRACTION
  - LEAVE IN “NEUTRAL” IN TRANSGASTRIC

Hilberath JN, et al. *JASE* (2010) 23:1115-1127

## COMPLICATIONS

Complication	Frequency
Overall Complication Rate	0.18 - 2.8%
Mortality	<0.01 - 0.02%
Major Bleeding	<0.01%
Bronchospasm	0.06 – 0.07%
Dysphagia	1.8%
Hoarseness	12%
Lip Injury	13%

Condensed from: Hahn et al. *JASE* (2013) 26:921-64

## ABSOLUTE CONTRAINDICATIONS

- ESOPHAGEAL PATHOLOGY
  - STRICTURE
  - DIVERTICULUM
  - MALLORY-WEISS TEAR
  - SCLERODERMA
  - TUMOR
  - TRAUMA
- KNOWN PERFORATION
  - ESOPHAGUS
  - STOMACH
- ACTIVE / RECENT GI BLEEDING
  - HEMATEMESIS, MELENA
  - RECENT DROP IN HEMOGLOBIN
- RECENT GI SURGERY
  - ESOPHAGECTOMY
  - BARIATRIC PROCEDURE
  - ESOPHAGOGASTRECTOMY
- RECENT OROPHARYNGEAL SURGERY

## RELATIVE CONTRAINDICATIONS

- DYSPHAGIA
- LESSER UGI DISEASE
  - ESOPHAGITIS, PEPTIC ULCER
  - VARICES
  - BARRETT'S ESOPHAGUS
  - DISTANT GI SURGERY
  - TREATED STRICTURES
- CERVICAL ABNORMALITIES
  - ATLANTO-AXIAL JOINT DISEASE
  - SEVERE CERVICAL ARTHRITIS
- HEMATOLOGIC ABNORMALITIES
  - COAGULOPATHY
  - THROMBOCYTOPENIA
- OROPHARYNGEAL ABNORM.
  - MALLAMPATI SCORE
  - LOOSE TEETH, PROSTHESES
- UNSTABLE RESPIRATORY STATUS



## APPROPRIATE USE CRITERIA

- ✓ TEE WHEN A HIGH LIKELIHOOD OF NON-DIAGNOSTIC TTE
- ✓ RE-EVALUATION OF PRIOR TEE FINDING WHEN MANAGEMENT MAY CHANGE
- ✓ GUIDANCE DURING NON-CORONARY CARDIAC INTERVENTIONS
- ✓ SUSPECTED ACUTE AORTIC PATHOLOGY
- ✓ EVALUATION OF VALVE STRUCTURE AND FUNCTION IN PLANNING FOR INTERVENTION OR SURGERY
- ✓ DIAGNOSE ENDOCARDITIS WITH MODERATE-HIGH PRETEST PROBABILITY
- ✓ EVALUATE FOR CARDIAC SOURCE OF EMBOLUS WITHOUT A NON-CARDIAC SOURCE
- ✓ FACILITATE DECISION MAKING REGARDING ANTICOAGULATION, CARDIOVERSION OR ABLATION IN AF

Douglas et al. 2011 AUC Echocardiography. JASE 2011;24:229-67

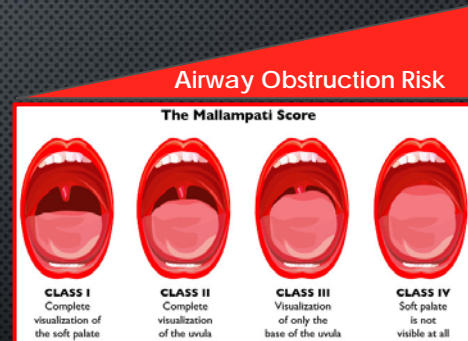
## APPROPRIATE USE CRITERIA

- ❖ ROUTINE USE OF TEE WHEN TTE IS DIAGNOSTIC
- ❖ RE-EVALUATION OF PRIOR TEE FINDING WHEN NO CHANGE IN THERAPY IS ANTICIPATED
- ❖ ROUTINE EVALUATION OF PULMONARY VEINS IN ASYMPTOMATIC PATIENT POST PVI
- ❖ DIAGNOSE INFECTIVE ENDOCARDITIS IN LOW PRETEST PROBABILITY PATIENTS
- ❖ EVALUATION FOR CARDIAC SOURCE OF EMBOLUS IN A PATIENT WITH A KNOWN CARDIAC SOURCE
- ❖ EVALUATION OF A PATIENT WITH AF WHEN DECISION HAS BEEN MADE TO ANTICOAGULATE AND CARDIOVERSION IS NOT PLANNED

Douglas et al. 2011 AUC Echocardiography. JASE 2011;24:229-67

## PATIENT PREPARATION

- NPO FOR 6 HOURS PRIOR TO STUDY
  - MINIMAL CLEAR LIQUIDS ACCEPTABLE
- PERIPHERAL IV ACCESS
- RISK STRAT — ANESTHESIA COMPLICATIONS
  - MALLAMPATI, ASA PHYSICAL STATUS
- AIRWAY EQUIPMENT
  - BITE BLOCK, O<sub>2</sub> SOURCE, SUCTION DEVICES
- BP, HR, SdO<sub>2</sub>, RR MONITORING
- ACLS SUPPORT EQUIPMENT / CERTIFIED STAFF MEMBER



## MODERATE CONSCIOUS SEDATION

- TOPICAL ANESTHESIA
  - BENZOCAINE, CETACAINE OR VISCOUS LIDOCAINE
    - METHEMOGLOBINEMIA RISK (BENZOCAINE) 0.07% - 0.12%
- CONSCIOUS SEDATION
  - SMALL, INCREMENTAL DOSES OF SHORT ACTING BENZODIAZEPINES
  - ADJUNCTIVE OPIOIDS FOR SYNERGISTIC EFFECT
  - PROPOFOL (*TYPICALLY ADMINISTERED BY ANESTHESIA*)



## LIVE A LIFE OF MODERATION!!

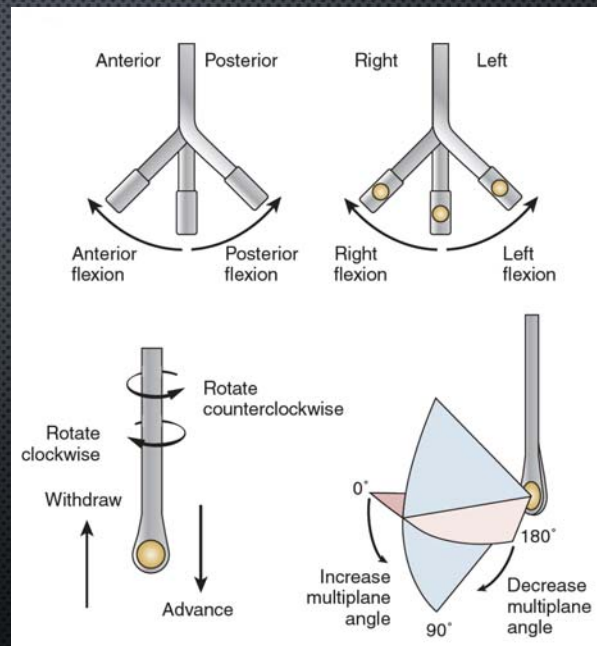
	Minimal <i>Anxiolysis</i>	Moderate <i>Conscious Sedation</i>	Deep <i>Analgesia</i>	General <i>Anesthesia</i>
<b>Responsiveness</b>	Normal response to verbal stimulation	Purposeful response to verbal or tactile stimulation	Purposeful response to painful stimulation	Unarousable, even with painful stimulus
<b>Airway</b>	Unaffected	No intervention	Intervention may be required	Intervention often required (Intubation)
<b>Spontaneous Ventilation</b>	Unaffected	Adequate	May be inadequate	Frequently inadequate
<b>CV Function</b>	Unaffected	Usually Maintained	Usually Maintained	May be impaired

"Continuum of Depth of Sedation: Definition of Anesthesia and Levels of Sedation"  
Am Soc Anesthesiol (2014)

## SPECIAL CONDITIONS

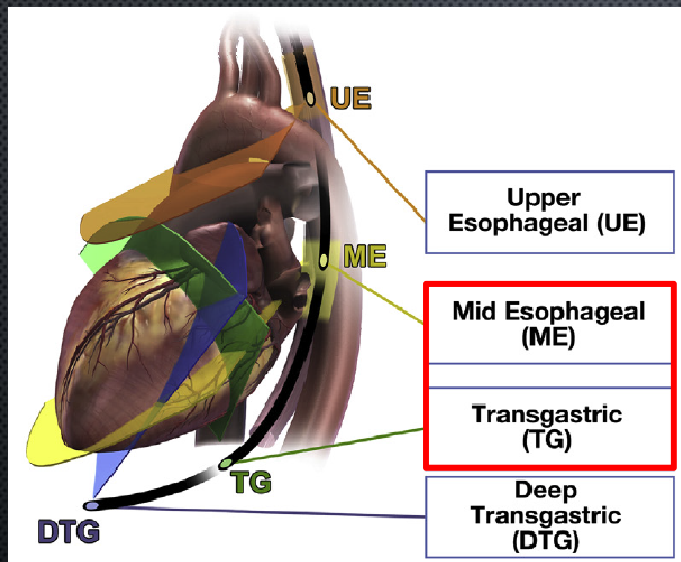
- ICU VENTILATED PATIENT
  - TOPICAL ANESTHESIA, BITE BLOCK
  - VARYING DEGREES OF SEDATIVES ALREADY ONBOARD
  - CAREFUL INSERTION TO AVOID ENDOTRACHEAL TUBE DISLODGE
  - NASO- / ORO-GASTRIC TUBE REMOVAL OR RE-CHECKING
- OPERATING ROOM
  - PATIENT SUPINE FOR SURGERY, BITE BLOCK AFTER INSERTION
  - TEE PROBE INSERTED FROM HEAD OF BED
  - MANDIBLE LIFT CAN FACILITATE ESOPHAGEAL INTUBATION

## OMNIPANE TEE CONTROL



Lo SS, et al. in Reich DL, "Perioperative Transesophageal Echocardiography" (2014) p 2-13

## ESOPHAGEAL AND GASTRIC IMAGING PLANES

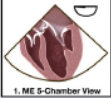

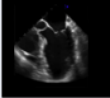
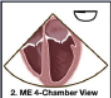

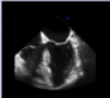

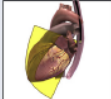
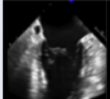





- 2013 ASE TEE GUIDELINES OUTLINE 28 "VIEWS" FOR A COMPLETE TEE
  - BE AS THOROUGH AS POSSIBLE
  - LET CLINICAL INDICATION BE YOUR GUIDE
  - STICK TO A "ROUTINE"
- CARDIAC ROTATION, TWISTING OR OTHER DEVIATION ALTER THE "STANDARD" PLANE

Hahn et al. JASE (2013) 26:921-64



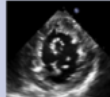










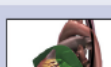



## ESOPHAGEAL VIEWS:

Imaging Plane	3D Model	2D TEE Image	Acquisition Protocol	Structures Imaged
<b>Midesophageal Views</b>				
 1. ME 2-Chamber View			<b>Transducer Angle:</b> ~ 0 - 10° <b>Level:</b> Mid-esophageal <b>Maneuver</b> (from prior image): NA	Aortic valve LVOT Left atrium/Right atrium Left ventricle/Right ventricle/IVS Mitral valve (A <sub>2</sub> -P <sub>1</sub> ) Tricuspid valve
 2. ME 4-Chamber View			<b>Transducer Angle:</b> ~ 0 - 10° <b>Level:</b> Mid-esophageal <b>Maneuver</b> (from prior image): Advance ± Retroflex	Left atrium/Right atrium IAS Left ventricle/Right ventricle/IVS Mitral valve (A <sub>2</sub> -P <sub>1</sub> ) Tricuspid valve
 3. ME Mitral Commissural View			<b>Transducer Angle:</b> ~ 50 - 70° <b>Level:</b> Mid-esophageal <b>Maneuver</b> (from prior image): NA	Left atrium Coronary Sinus Left ventricle Mitral Valve (P <sub>2</sub> -A <sub>2</sub> , A <sub>1</sub> -P <sub>1</sub> ) Papillary muscles Chordae tendinae
 4. ME 2-chamber View			<b>Transducer Angle:</b> ~ 80 - 100° <b>Level:</b> Mid-esophageal <b>Maneuver</b> (from prior image): NA	Left atrium Coronary sinus Left atrial appendage Left ventricle Mitral valve (P <sub>2</sub> -A <sub>2</sub> , A <sub>1</sub> )

Hahn et al. JASE (2013) 26:921-64






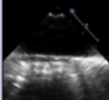


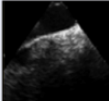


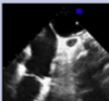
## TRANSGASTRIC VIEWS

<b>Transgastric Views</b>				
 16. TG Basal SAX View			<b>Transducer Angle:</b> ~ 0 - 20° <b>Level:</b> Transgastric <b>Maneuver</b> (from prior image): Advance ± Anteflex	Left ventricle (base) Right ventricle (base) Mitral valve (SAX) Tricuspid valve (short-axis)
 17. TG Mid Papillary SAX View			<b>Transducer Angle:</b> ~ 0 - 20° <b>Level:</b> Transgastric <b>Maneuver</b> (from prior image): Advance ± Anteflex	Left ventricle (mid) Papillary muscles Right ventricle (mid)
 18. TG Apical SAX View			<b>Transducer Angle:</b> ~ 0 - 20° <b>Level:</b> Transgastric <b>Maneuver</b> (from prior image): Advance ± Anteflex	Left ventricle (apex) Right ventricle (apex)
 19. TG RV Basal View			<b>Transducer Angle:</b> ~ 0 - 20° <b>Level:</b> Transgastric <b>Maneuver</b> (from prior image): Anteflex	Left ventricle (mid) Right ventricle (mid) Right ventricular outflow tract Tricuspid Valve (SAX) Pulmonary Valve
 20. TG RV Apical View			<b>Transducer Angle:</b> ~ 0 - 20° <b>Level:</b> Transgastric	Right atrium Right ventricle Right ventricular

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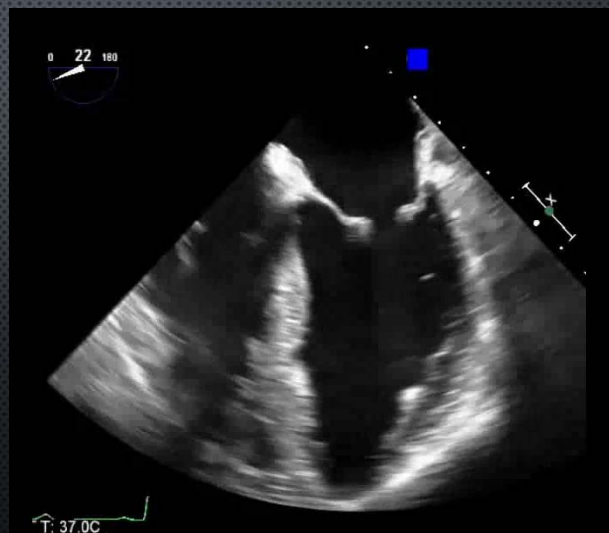
## AORTIC VIEWS

### Aortic Views

 <p>25. Descending Aorta SAX View</p>		 <p><b>Transducer Angle:</b> ~ 0 - 10° <b>Level:</b> Transgastric to Mid-esophageal <b>Maneuver</b> (from prior image): Neutral flexion</p>	<p>Descending aorta Left thorax Hemiazygous and Azygous veins Intercostal arteries</p>
 <p>26. Descending Aorta LAX View</p>		 <p><b>Transducer Angle:</b> ~ 90 - 100° <b>Level:</b> Transgastric to Mid-esophageal <b>Maneuver</b> (from prior image): Neutral flexion</p>	<p>Descending aorta Left thorax</p>
 <p>27. UE Aortic Arch LAX View</p>		 <p><b>Transducer Angle:</b> ~ 0 - 10° <b>Level:</b> Upper Esophageal <b>Maneuver</b> (from prior image): Withdrawl</p>	<p>Aortic arch Innominate vein Mediastinal tissue</p>
 <p>28. UE Aortic Arch SAX View</p>		 <p><b>Transducer Angle:</b> ~ 70 - 90° <b>Level:</b> Transgastric to Mid-esophageal <b>Maneuver</b> (from prior image): NA</p>	<p>Aortic arch Innominate vein Pulmonary artery Pulmonary valve Mediastinal tissue</p>

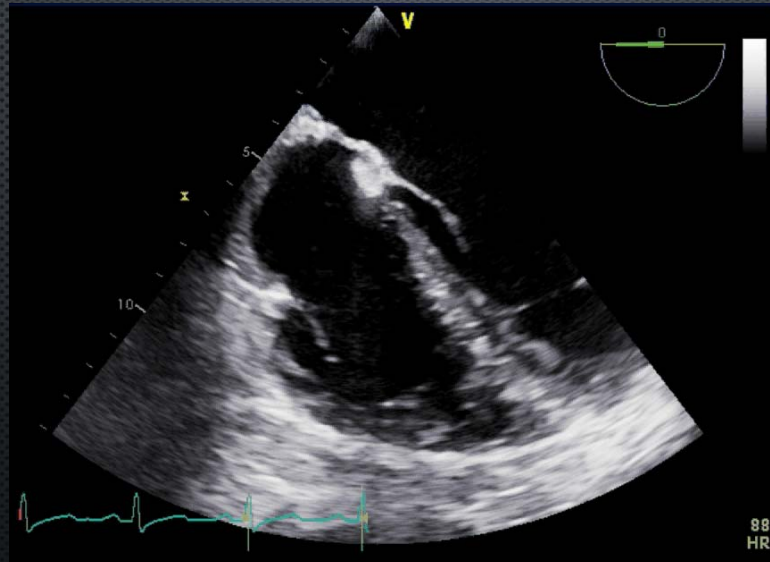
Hahn et al. *JASE* (2013) 26:921-64

## FOUR CHAMBER VIEW

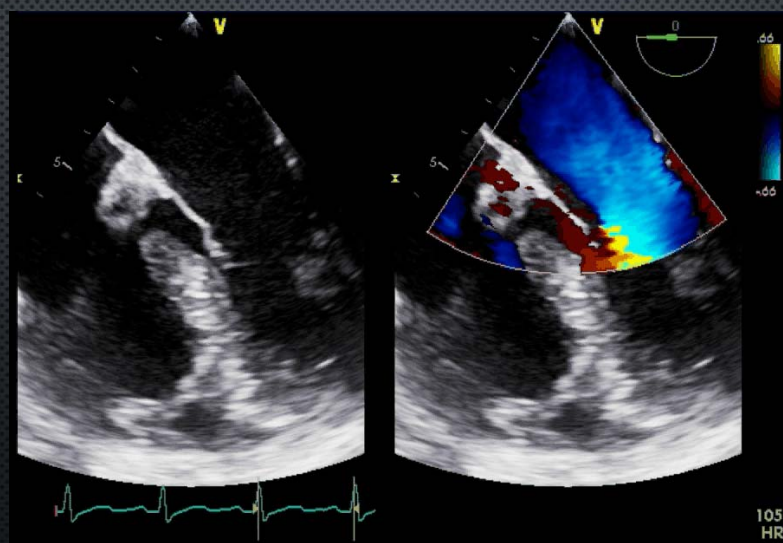




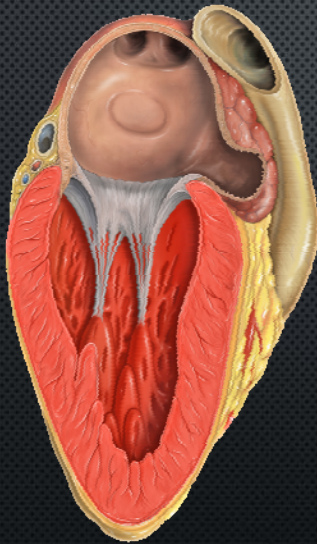
## TILTED FOUR CHAMBER VIEW



## FOUR CHAMBER VIEW CFD



## TWO CHAMBER VIEW



## AORTIC VALVE



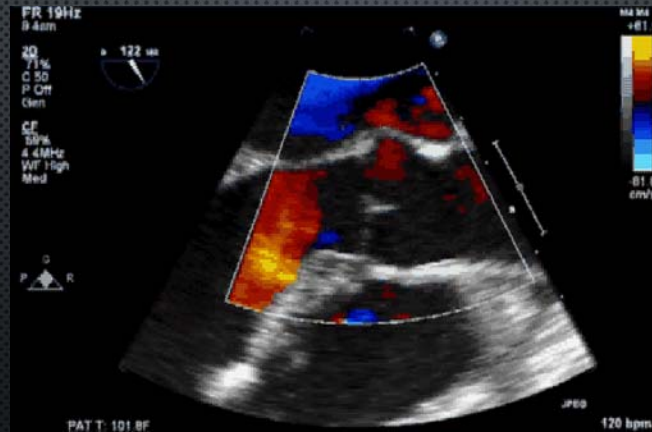
ME SAX



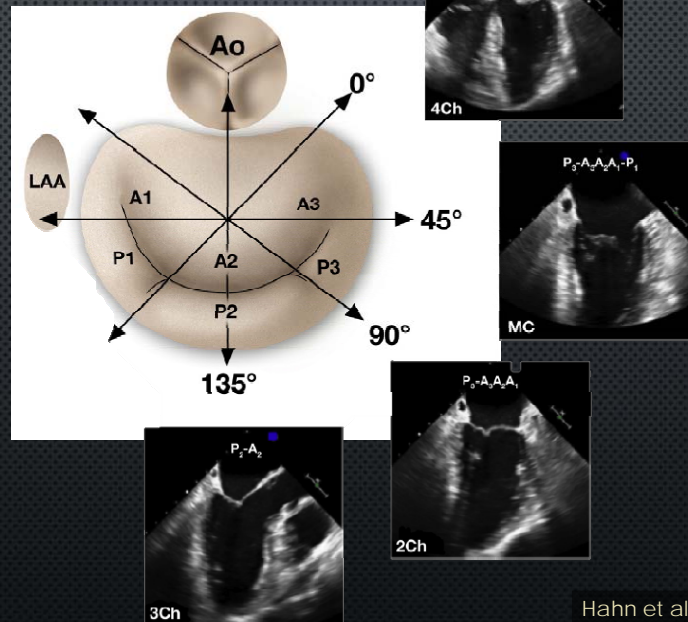
ME LAX



## AORTIC VALVE CFD

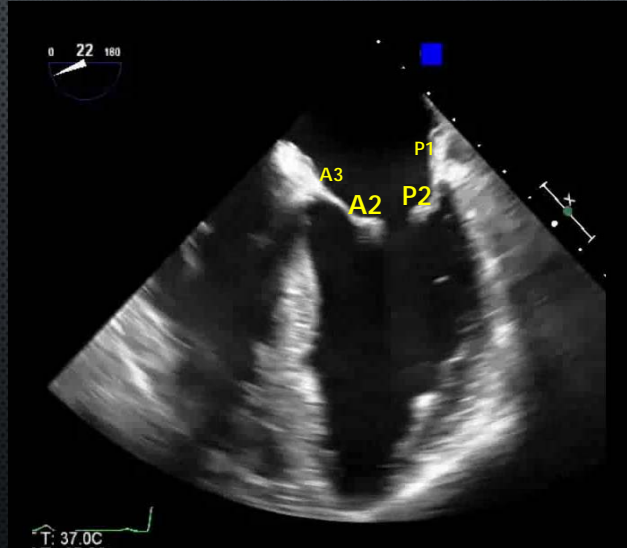


## MITRAL VALVE

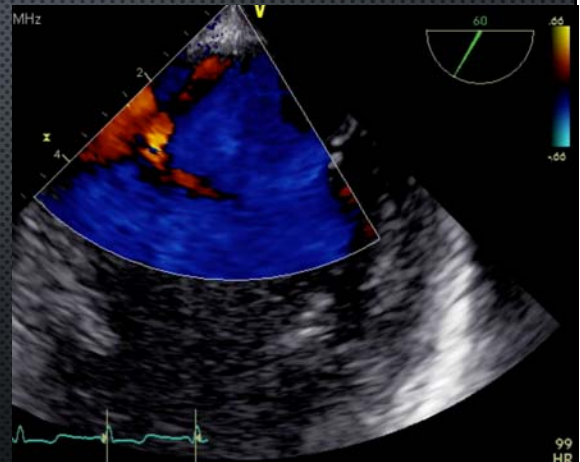
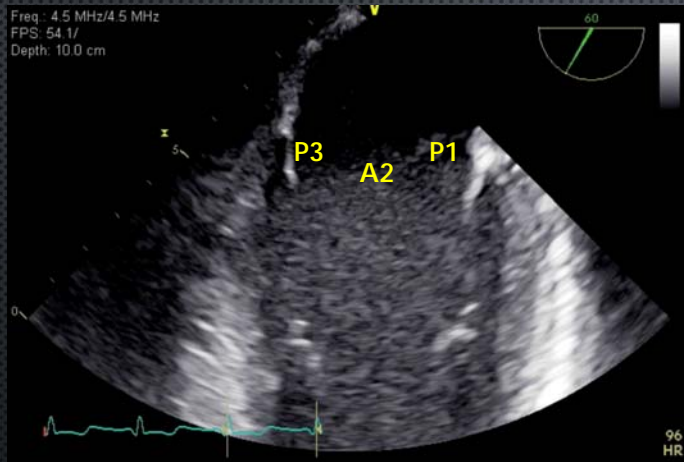


Hahn et al. JASE (2013) 26:921-64

## MID ESOPHAGEAL "4 CHAMBER" VIEW (0 - 20°)

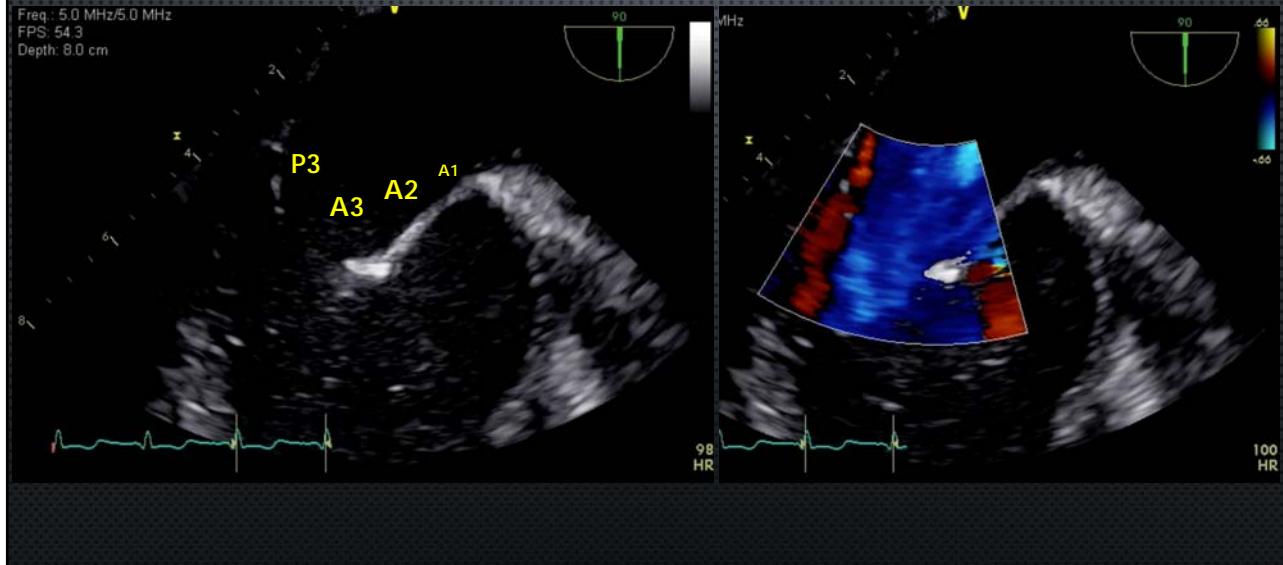


## MID ESOPHAGEAL "MID-COMMISSURAL" VIEW (45 - 60°)

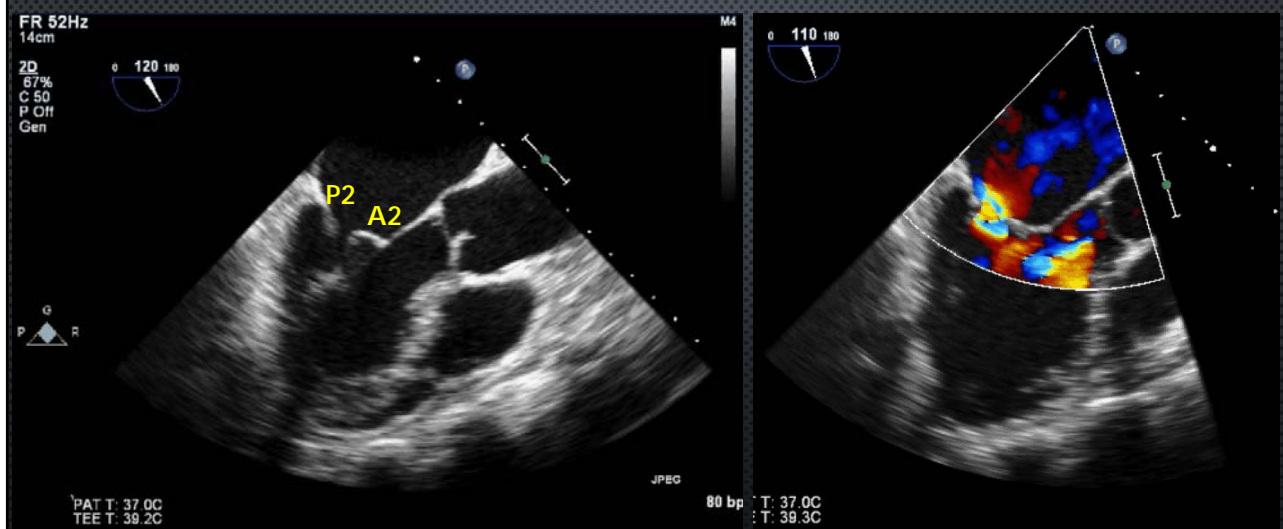




## MID ESOPHAGEAL "2 CHAMBER" VIEW (90°)



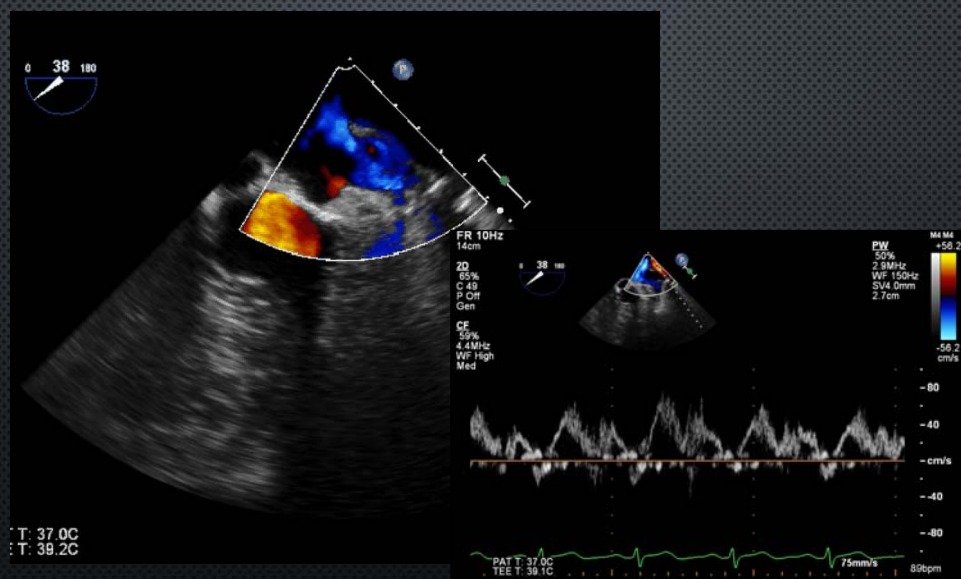
## MID ESOPHAGEAL "3-CHAMBER" VIEW (120 - 135°)



## ME LEFT ATRIAL APPENDAGE



## ME PULMONARY VEINS

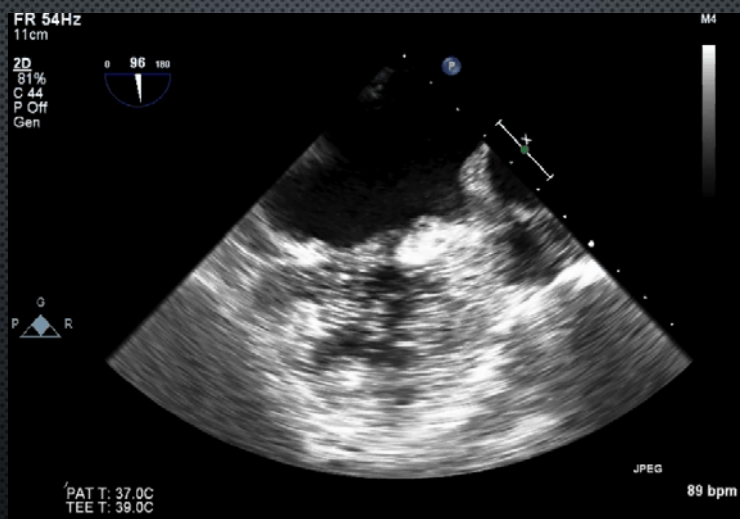




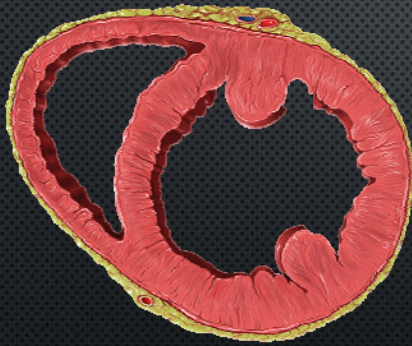
## ME BICAVAL VIEW



## ME BUBBLE STUDY



## TRANSGASTRIC SAX



## TRANSGASTRIC LV

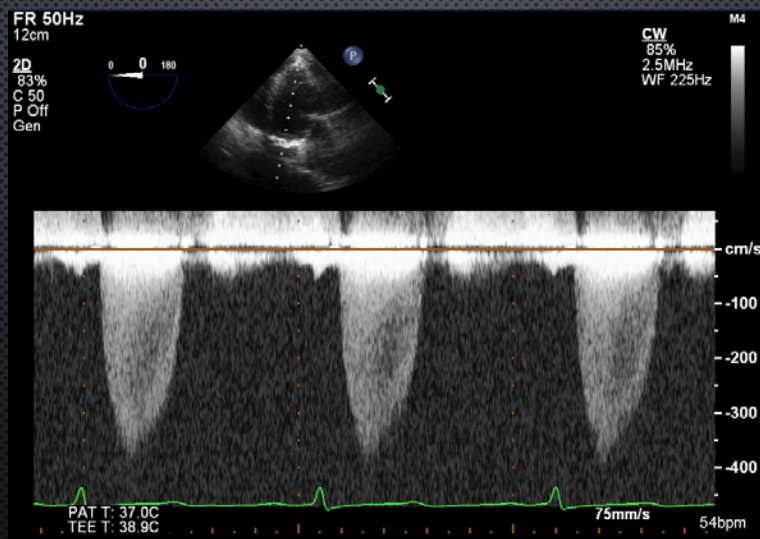




## DEEP TRANSGASTRIC



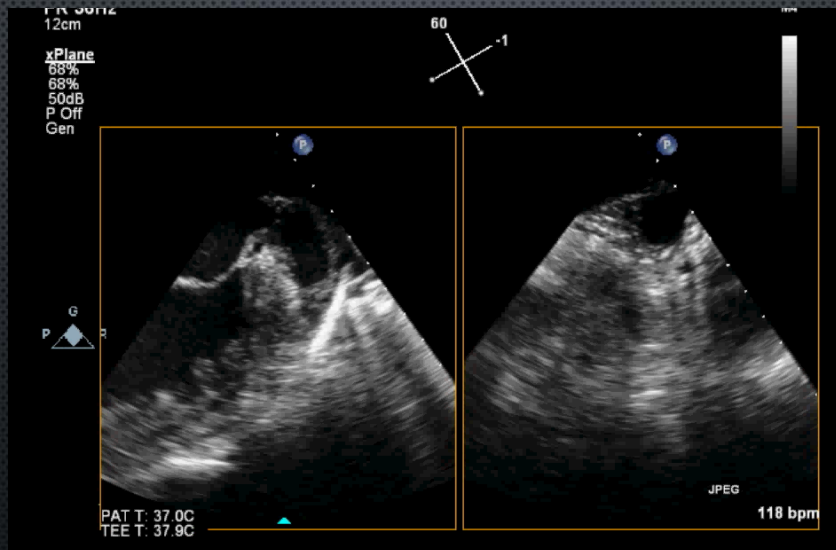
## DEEP TRANSGASTRIC CW



## "SPECIAL APPLICATIONS" OF TEE

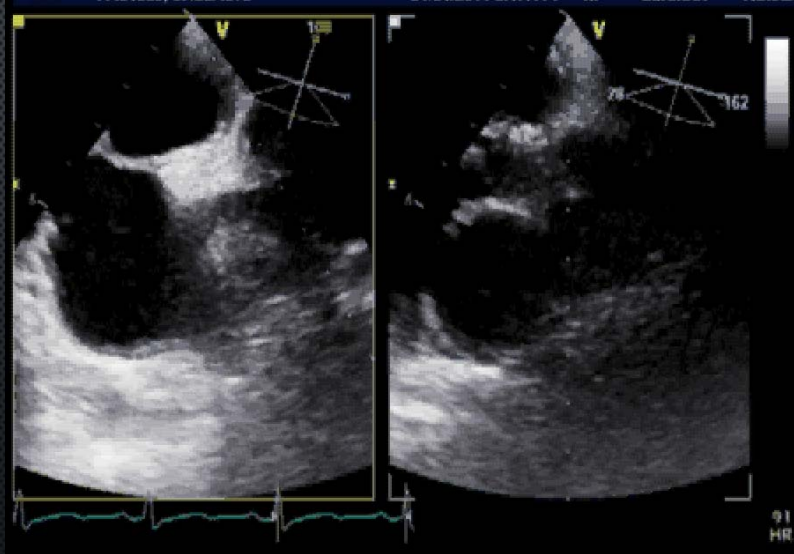
- YOU SHOULD HAVE FAMILIARITY WITH THE FOLLOWING:
  - MULTI-PLANE IMAGING
  - 3D IMAGING
  - INTERVENTIONAL ECHOCARDIOGRAPHY
- YOU WILL NOT BE ASKED ABOUT WHETHER THE MITRAL CLIPPING DEVICE GRASP IS ACCEPTABLE...ETC...

## MULTIPLANE LAA

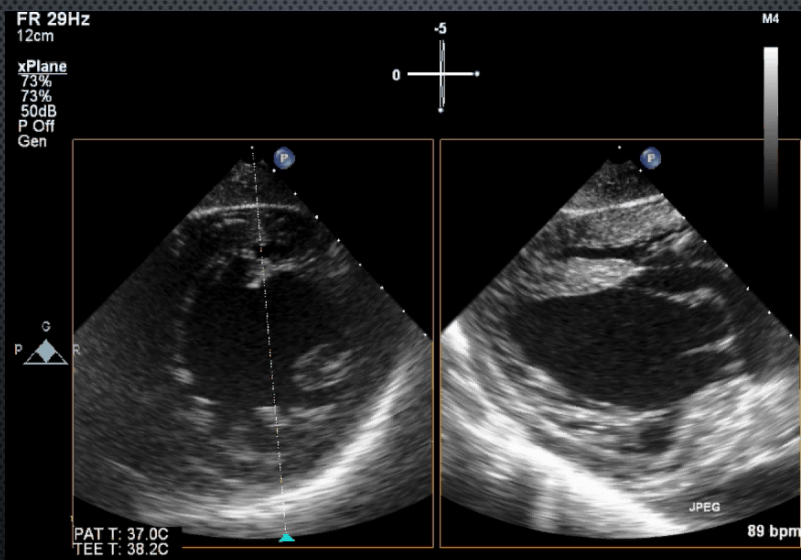




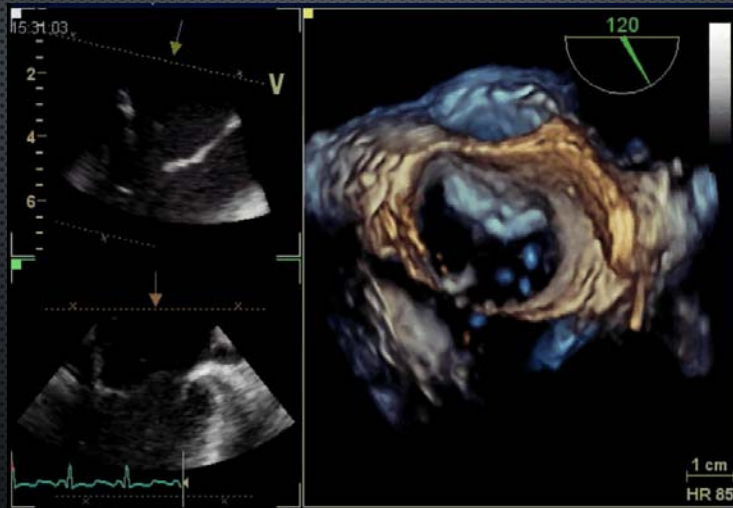
## MULTIPLANE SVC



## MULTIPLANE TRANS-GASTRIC

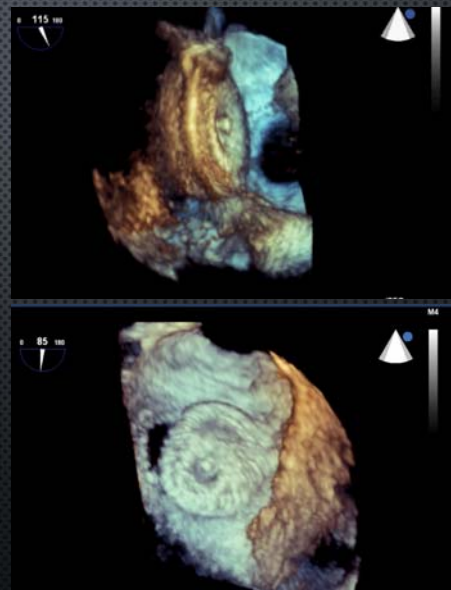


## 3D TEE IMAGING



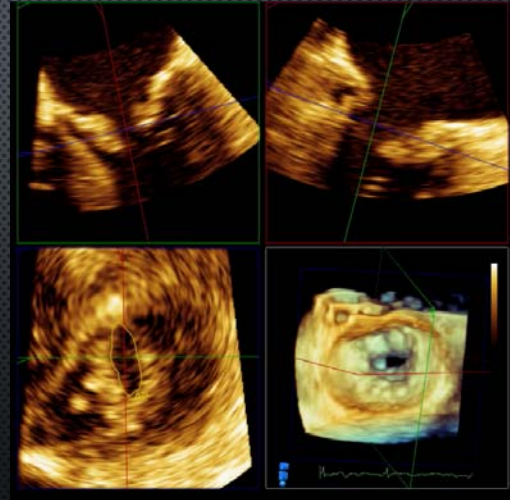
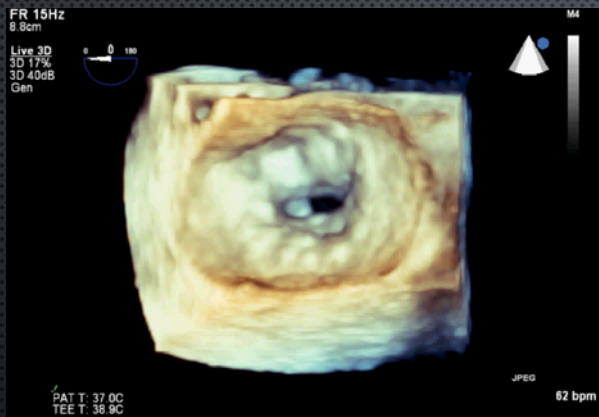
- LOTS MORE 3D IMAGING TO COME ON MONDAY...

## INTERVENTIONAL – ASD CLOSURE

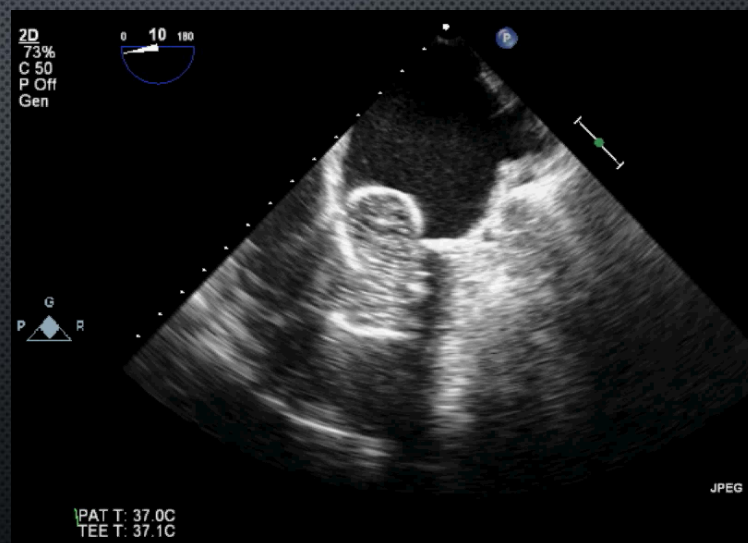
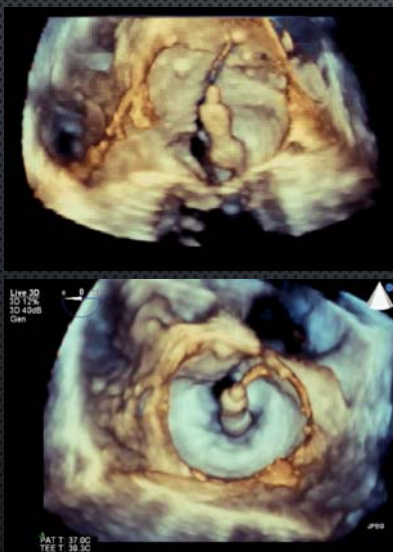




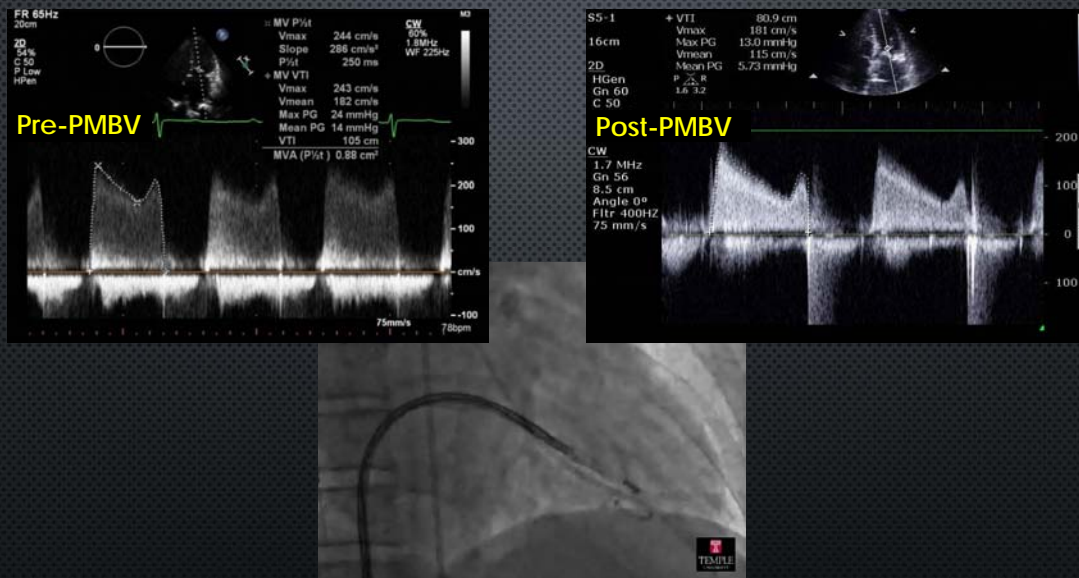
## INTERVENTIONAL – MITRAL STENOSIS



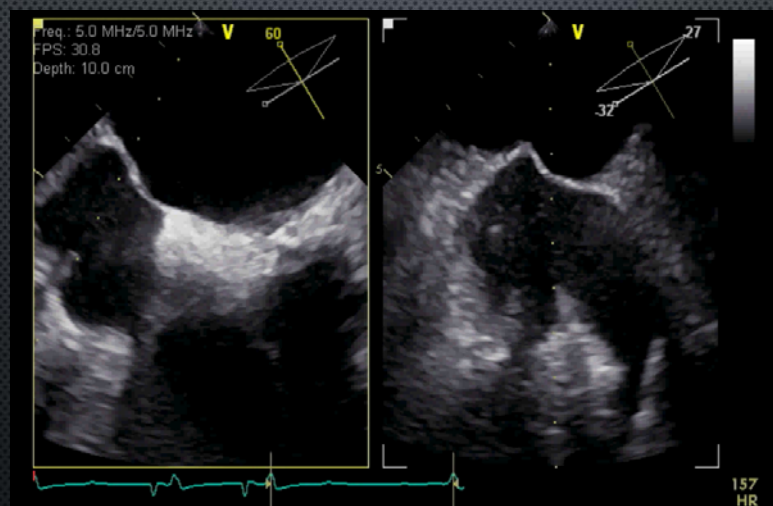
## INTERVENTIONAL – MV VALVULOPLASTY



## PRE / POST VALVULOPLASTY



## INTERVENTIONAL – TRANSSEPTAL PUNCTURE

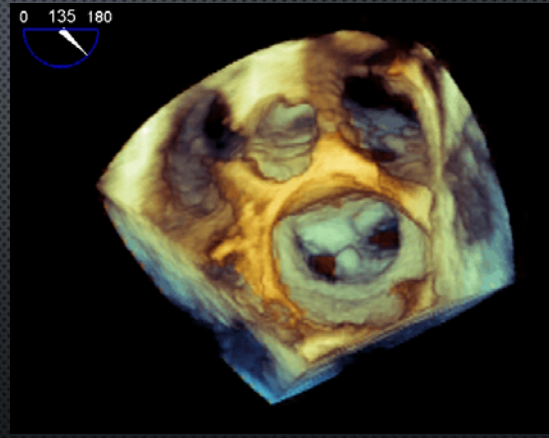




## INTERVENTIONAL – MITRACLIP™

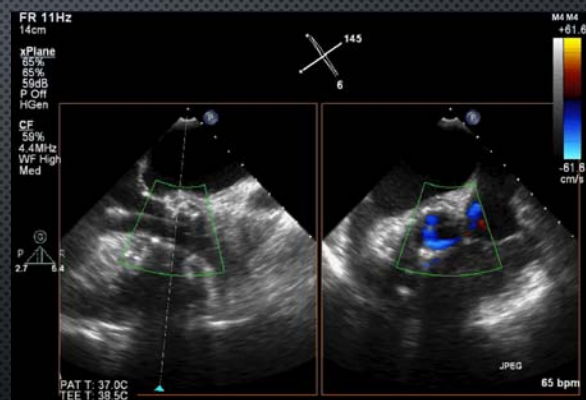


Orienting the Clip – A3/P3 Prolapse

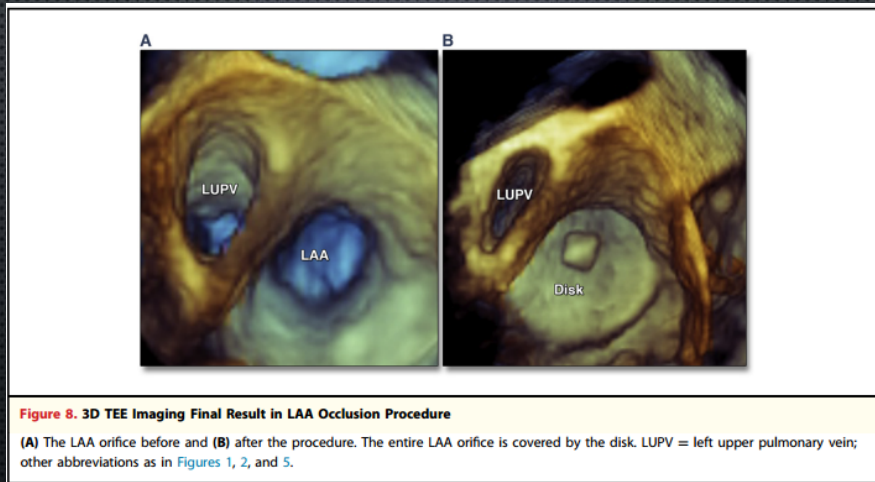


Clip Deployed – A2/P3 Prolapse

## INTERVENTIONAL - TAVR

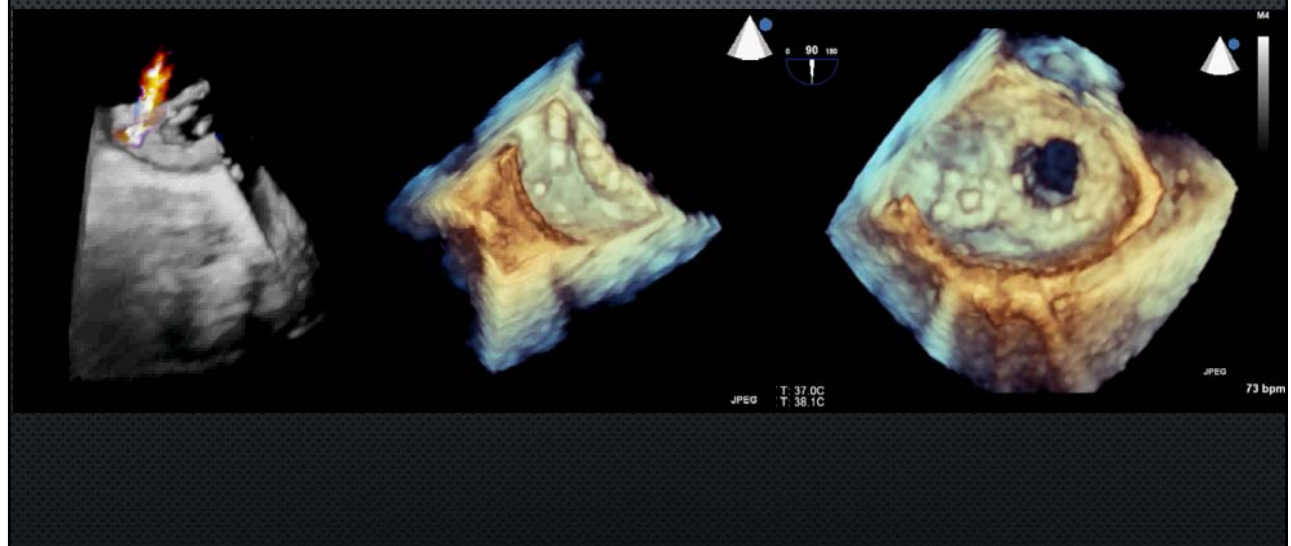


## INTERVENTIONAL – LA APPENDAGE EXCLUSION



Faletra, et al. *JACC Imaging* (2014) 7:292-308

## INTERVENTIONAL – PARAVALVULAR LEAK CLOSURE





## SUMMARY – WHAT DO I NEED TO KNOW?

- INDICATIONS AND CONTRAINDICATIONS
  - MAJOR APPROPRIATE USE CONCEPTS (FORGET THE “U”-s)
- PATIENT EVALUATION AND PREPARATION
  - BOTH PROBE-RELATED AND SEDATION-RELATED
- COMPLICATIONS – DURING AND AFTER
- MAJOR VIEWS AND STRUCTURES
  - MEMORIZATION + PATTERN RECOGNITION
  - **MV SEGMENT ID ON PRIMARY 2D MAGE PLANES**
  - MULTIPLANE IMAGES – MIND THE OMNI
- ADJUNCT TO INTERVENTIONAL PROCEDURES